



**U.S. Department of Energy
Electricity Advisory Committee Meeting
NRECA Conference Center
Arlington, VA
September 29, 2015**

Summary of Meeting

PARTICIPANTS

EAC:

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Electric Reliability Council of Texas

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Orkas Energy Endurance Inc.

WILLIAM BALL
Southern Company

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California Independent System Operator

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AES Energy Storage

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Speakers, Guests and Members of the Public:

STEPHANIE AYERS
IMCORP

DERECK BANDERA
Midcontinent Independent System Operator

VENKAY BANUNASAYANAN
National Rural Electric Cooperative Association

ADAM BENSHOFF
Edison Electric Institute

DOREEN BYRNE

EDWARD CAZALET
TexMic Inc. and MegaWatt Storage Farms, Inc.

CYNTHIA HSU
House Community Science, Space and Technology

PATRICK HUGHES
National Electrical Manufactures Association

MARK IRWIN
Southern California Edison

SUSAN KENNEDY
Advanced Microgrid Solutions

MARY ELLEN PARAVALOS
National Grid

JOHN SHELK
Electric Power Supply Association

EMMANUEL TAYLOR
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ICF/Support:

RACHEL FINAN
ICF International

MAUREEN MALLOY
ICF International

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ANDREA WAGNER
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EAC Ethics Briefing

Mr. Brian Plessner, DOE Office of General Council, was unable to attend the meeting and the ethics briefing was postponed.

Welcome, Introductions, Developments since the September 2015 Meeting

Mr. Richard Cowart, Electricity Advisory Committee (EAC or the Committee) Chair, and Matthew Rosenbaum, EAC Designated Federal Officer (DFO), welcomed the new and returning Committee members.

Mr. Cowart invited all members to introduce themselves and reviewed the agenda, explaining that one document is up for formal approval by the Committee (i.e., ARRA Accomplishments and Recommendations for Moving Forward paper). He noted that all discussion will be recorded by transcript and available to the public.

Update on the DOE Office of Electricity Delivery and Energy Reliability's Programs and Initiatives

Honorable Patricia Hoffman, Assistant Secretary for Electricity Delivery and Energy Reliability, provided an update on the Department of Energy (DOE or the Department) Office of Electricity Delivery and Energy Reality Program (OE) initiatives.

Ms. Hoffman explained that the Quadrennial Technology Review (QTR) was released in September 2015. The goal of the QTR was to review what technology options and solution sets exist for a variety of activities under DOE jurisdiction (e.g., end use technologies). Ms. Hoffman noted that the QTR is available on the website. The Department has posted several documents that supported the development of the QTR and additional documents will be posted in the near future.

Ms. Hoffman explained that September 30th marks the end of the American Recovery and Reinvestment Act of 2009 (ARRA or Recovery Act) funds. She highlighted several reports on the DOE website that address success stories and lessons learned.

Ms. Hoffman provided an update on the energy storage sector. She highlighted DOE's work with Washington State and Pacific Northwest National Laboratory (PNNL) that examines the use of flow batteries to support the electric system. PNNL also opened a new laboratory in August to focus on cybersecurity issues and she mentioned the State of Vermont's project, in collaboration with the Vermont Public Service Department, to determine the feasibility of using a microgrid to provide power during an emergency.

Ms. Hoffman summarized that DOE activated 13 incidents of emergency for events including tropical storms, cold weather, and wildfires. The transmission area released two Environmental Impact Statements (EIS). DOE began work with developers to finalize a pre-application process for permit requests that fall under DOE responsibility.

Ms. Hoffman provided an overview of expected DOE 2016 efforts. The Department expects to continue reviewing the major grid issues including advanced technology, transmission, and cybersecurity. DOE intends to review additional issues including smart cities initiatives and investing in grid architecture. She noted that DOE will continue to invest for the future and review data and data management.

Update on the DOE Grid Modernization Initiative

Mr. Bill Parks, Senior Technical Advisor for Office of Electricity Delivery and Energy Reliability, and Kevin Lynn, Office of Energy Efficiency and Renewable Energy, provided an update on the DOE Grid Modernization Initiative (GMI).

Mr. Lynn explained that the existing power system cannot meet all the demands of the 21st century, which is driving the transformation of the grid. The key drivers behind this transformation include a changing mix of types and characteristics of electric generation, growing demands for a more resilient and reliable grid, growing supply and demand-side opportunities for customers to participate in electricity markets, the emergence of interconnected electricity information and control systems, and an aging infrastructure.

Mr. Lynn stated that the future grid provides a critical platform for U.S. prosperity,

competitiveness, and innovation in a global clean energy economy. Grid modernization must deliver reliable, affordable, and clean electricity to consumers where, when, and how they want it. He provided information on how to simultaneously manage the key attributes of a modernized grid. DOE is working with the Grid Modernization Laboratory Consortium (GMLC) on these tasks.

Mr. Lynn explained GMI's integrated technical pushes, which include institutional support, design and planning tools, system operations, power flow and control, sensing and measurements, devices and integrated system testing, and security and resilience. He highlighted the connectivity to other DOE activities such as the QER policy options, QTR technology options, and the integrated lab call with the GMLC. Mr. Lynn explained the GMLC and its organizational structure. The DOE grid modernization lab call attempted to develop a baseline and core activities to establish a foundation for the six technical pushes.

Mr. Lynn provided examples of major DOE achievements. The Lean Bulk Power Systems incorporated all the main aspects of grid modernization such as reliability, affordability, and security. Another example was the Clean Distribution Systems which coordinated microgrids control for resilience (e.g., 20% fewer outages and 50% shorter recovery time). Mr. Lynn highlighted the Grid Planning and Analytics.

Mr. Lynn stated what was requested of the EAC in the plans for FY16. He discussed the Multi-Year Program Plan (MYPP) and the comments on the FY16 lab call activities. The MYPP will be revised into a second version, based on these discussions, and technical workshops are expected to follow.

Mr. Merwin Brown asked whether DOE pre-allocated the dollar amount going to each lab call activity or if the conversation determined the allocation. Mr. Lynn replied that DOE did pre-allocate the amount. He noted that the exact amount information is available on the website.

Mr. William Ball asked when the six technical workshops would be held and Mr. Lynn explained that the technical workshops will be scheduled between the January and March 2016 timeframe. He noted that DOE intends to host a grid summit to review version 1 and discuss version 2 of the Multi-Year Program Plan (MYPP). Mr. Ball encouraged DOE to publish the dates as soon as possible to ensure interested parties can attend. Mr. Cowart asked if DOE has determined the topics and locations of the workshops. Mr. Lynn responded that each workshop will address a chapter/technical area.

EAC Member Discussion of the Grid Modernization Initiative Working Group Plans

Mr. Anjan Bose, EAC Member and Working Group Chair, provided an update on the plans of the GMI Initiative working group. Mr. Bose explained that the working group was formed after the last EAC meeting to help with the grid modernization effort and has since participated in several telephone and one in-person meeting to lay out the purpose and task of the group.

Mr. Bose explained that one task of the working group is to provide feedback on the final chapters

of the MYPP (five technical chapters and one institutional chapter). He noted the difficulty in providing feedback because the chapters are not separated. The working group suggested DOE create an executive chapter that explains the integration of the chapters.

Mr. Bose said that additional tasks will result from the projects that the laboratories will embark on within the next four to six weeks. He noted the moving landscape of the GMI from the QTR and MYPP. DOE is working on budget tasks to ensure that grid modernization research continues based on funding.

High Penetration of Energy Storage Panel

Chris Shelton introduced the High Penetration of Energy Storage panelists including: Edward Cazalet, TeMix Inc. and MegaWatt Storage Farms, Inc., Susan Kennedy, Advanced Microgrid Solutions, John Shelk, Electric Power Supply Association, and Mark Irwin, Southern California Edison.

The first panelist, Edward Cazalet, TeMix Inc. and MegaWatt Storage Farms, Inc., presented on the role of transactive markets in high penetration of energy storage. Mr. Cazalet reviewed the keys to high penetration of storage, which include understanding what will drive and what will inhibit high penetration of storage. He reviewed that low cost solar and the quest for resiliency and clean energy will be factors in driving high penetration of storage. However, attempts to centrally dispatch distributed and behind the meter storage with many locations, chemistries, sizes, and response rates will inhibit high penetration of storage.

Mr. Cazalet presented the four big ideas of transactive energy. First is using forward transactions to coordinate investments and manage risk. Second is using transactions to coordinate operating decisions. The third idea is that all parties act autonomously and lastly, the two products of energy and transport are key ideas of transactive energy. Mr. Cazalet reviewed the structure of transactive energy markets and the interaction between platforms, parties, and intermediaries.

The second panelist, Susan Kennedy, Advanced Microgrid Solutions (AMS), presented on energy storage progress at AMS. She provided an overview of their 10 megawatt hybrid-electric building project that includes 26 commercial office buildings. The project will offer 25 percent peak demand reduction and an annual savings of \$900,000. She also highlighted several other AMS projects.

Ms. Kennedy reviewed peak shaving and utility capacity. She noted the full deployment of energy storage from building standards, distribution systems, utilities, and wholesale markets. Ms. Kennedy discussed whether the load curve would be met or reshaped under new projects. Utility spending is on track to meet \$1 trillion within the next decade. She explained that the load curve could be reshaped using DER. Ms. Kennedy reviewed behind the meter energy storage. She commented on the vision for fully-automated, intelligent, verifiable, dynamic load management by the 2020s and summarized the end value chain with energy storage.

The third panelist, John Shelk, Electric Power Supply Association, presented an overview of the Electric Power Supply Association (EPSA). EPSA members are the nation's leading competitive wholesale suppliers with over 120,000 megawatts of capacity that use all fuels and technologies. He explained that the total competitive power sector is 40 percent of installed U.S. capacity.

Mr. Shelk explained energy storage in a broader context. The electricity resource mix is changing and will continue to change rapidly due to technologies and public policy. Mr. Shelk noted that competition is increasing and the rise of intermittent resources is creating stress on the system. He commented that despite these changes, the need for reliable service to consumers is not changing.

Mr. Shelk provided a high level overview of EPSA points on storage policy. He noted that storage policy must fit within the broader competitive landscape and should be market driven rather than based on pre-ordained storage penetration levels for utilities to install. Mr. Shelk supported a full discussion of the range of legal and practical issues on the topic of energy storage. He noted that even with high growth rates, storage is projected to be a very small part of the grid in the near term but the system must remain reliable at all times.

The fourth panelist, Mark Irwin, Southern California Edison, provided an overview of Southern California Edison's view on energy storage. He explained the various aspects of the SCE storage approach including technology, laboratory evaluation, system or sub-system laboratory testing, field demonstration and pilots, and system deployment.

Mr. Irwin presented on the challenge of storage distribution value, noting that SCE believes utilities could benefit from its exploring. He noted that measuring, monetizing, and capturing storage distribution values still remains a challenge. Mr. Irwin reviewed the remaining challenges and gaps including demonstrating required reliability at the system level, validating large systems prior to deployment, capturing promised value streams in actual applications, and building positive business cases. He noted that the availability of truly grid-ready integrated systems is a challenge.

Mr. Shelton thanked the panelists for their presentations and began the roundtable discussion.

Mr. Shelton asked about the definition of high penetration of energy storage. Mr. Cazalet responded that, in terms of California, their target is to have 50 percent renewable generation by 2030. Studies have illustrated tremendous amounts of generation is wasted over the year. Mr. Cazalet and Ms. Kennedy discussed using storage and rate reform to recover this wasted energy, suggesting measuring the amount of the distribution system that can be replaced by storage and mitigating the cost of an estimated 30 to 40 percent of feeders by using some type of demand responses. Mr. Irwin and Mr. Shelk discussed the importance of knowing what storage

is being used for on a particular system and agreed that state policy is likely going to cause changes in storage implementation and cost nationwide. Peak compensation needs to change so prices match peak load generation values so storage becomes economically feasible.

Mr. Shelton asked Mr. Irwin about the system wide implications of high penetration of energy storage. Mr. Irwin explained that broader storage development will create more value opportunities but understanding what the value proposition looks like remains one of the biggest challenges today, despite recent progress in this area made in the market place. Mr. Cazalet added that the situation is different in states with renewable targets at 100 percent (e.g., California, Hawaii); There is no way to calculate marginal cost in these states where variance load and usage price formation is on the customer side and there is no generation to dispatch, which creates a different market.

Mr. Shelton asked what action needs to be taken to make high penetration of renewables or of storage possible. Ms. Kennedy noted the “chicken-and-egg” aspect of the question. The California scenario was evolutionary in the sense that state procurements resulted in active market purchases and system additions of storage by utilities. Current market rules need to change so they no longer dictate utilities purchase of unnecessary goods and services.

Mr. Shelton asked the panelists their final thoughts on what aspects should be included in the energy storage paper. Panelists agreed that storage penetration will be evolutionary rather than revolutionary and will be determined by a number of factors. The right price formation and signals, retail tariffs, rate design, and market values of storage will be critical for a high level of storage penetration and where on the system it will occur (e.g. behind the meter, in the market, or both). Panelists encouraged DOE to ensure storage discussion is reasonable and comprehensive and suggested discussions include regional variations, are evolutionary, and involve rate makers.

EAC Member Discussion of High Penetration of Energy Storage Panel

Mr. Sioshansi argued that the organized market in the U.S. has moved away from simple and decentralized coordination to centralized and non-linear complexities. Mr. Cazalet suggested that dispatch of storage transmission and generation should be more incremental so the price paid for transmission reflects what is being used at that point as opposed to centrally dispatching both generation and storage, but noted that more research could address this issue. Mr. Brown added that the high penetration of energy storage is going to be primarily a distribution phenomenon, with big storage like compressed air, pump tide row, or even large battery systems, and not on transmission level. Mr. Irwin responded that the market will drive the level of storage added to the three types of systems (i.e., behind the meter, on the distribution system, and transmission).

Mr. Centolella asked if there is a difference in storage value based on the location in the system due to variations in factors such as VAr support and marginal losses. Mr.

Shelk and Mr. Irwin agreed that distributional value is very location-specific and every scenario should be evaluated as reasonable to avoid missing something.

Mr. Coe, Mr. Cazalet, Mr. Irwin, and Ms. Kennedy discussed if energy storage is at or beyond the tipping point where the development of this is a foregone conclusion and agreed that this is true in certain locations but the appetite for storage development is enormous and costs are decreasing so development will continue. However, the rate at which it will continue is difficult to predict.

Mr. Van Welie commented that there exists a well-functioning transactive energy market model in the U.S. and most of the infrastructure is built on a forward contracting model that has a very high penetration of storage. He asked if policy makers and regulators would allow the electric industry to decrease reliability in order to reach the transactive energy model. Mr. Cazalet responded customers are making forward contracts, either buying their own systems or forward contracting with third parties, their basic needs are provided. So when the prices get very high, nobody's hurting, everybody's got the opportunity to conserve and sell to their neighbors at a very high price above what their basic needs are, which already have been contracted for them.

Ms. Lin commented that there are opportunities for DOE to assist in exploring ways to get systems deployed. She suggested that the issue of scenarios be added to their agenda and volunteered to assist.

Mr. Bose asked if, under present circumstances, there are already scenarios where there is value to utilities for adding storage to their systems. Mr. Irwin responded that there is value to adding storage systems. The biggest value is for urban utilities that have a lot of underground systems but storage is still expensive. Mr. Cazalet added that if there is no market, then there needs to be a mandate from the legislature to help guide the utilities on storage.

Mr. Brown asked for the panelists' thoughts on the role energy storage will play in the future. Ms. Kennedy responded that storage is going to completely change the industry (similar to what happened in the telecommunications industry). Mr. Cazalet responded that storage has already changed the industries and there is now a clear vision for the role of storage in the future. Mr. Irwin added that storage is going to be a choice, but we will likely see wide deployment in the future. In states that have policy issues driving the system, the choice will happen sooner (e.g., California).

EAC Energy Storage Subcommittee Activities and Plans

Mr. Brown, EAC Energy Storage Subcommittee Chair, provided an update on the Energy Storage Subcommittee activities and plans. He highlighted the subcommittee's current effort on the Distributed Energy Storage in the Electric Grid white paper that is expected to be completed in 2016, with the assistance of the Smart Grid Subcommittee.

High Storage Penetration Scenario Analysis Paper

Mr. Brown and Mr. Shelton provided an update on the High Penetration of Energy Storage paper that is scheduled for completion in 2016. The Subcommittee reviewed the electric grid consequences if high penetration of energy storage deployments occurred as expected. High penetrations of energy storage are expected to bring substantial benefits to the production, delivery and use of electricity but the grid needs better understanding of the potential benefits versus dislocations of high penetrations of energy storage.

The purpose of the white paper is to qualitatively examine the implications of high penetrations of energy storage on electric transmission and distribution systems. Additionally, it serves to provide a framework for identifying measures to more thoroughly characterize the vision of energy storage as an agent in the grid, both physically and institutionally, with DOE as the intended audience.

Mr. Brown provided an overview of the simplified scenario planning process that the Energy Storage Subcommittee is using. Two highly uncertain variables will serve as the axis for four quadrants that each represent the logical implications of cause and effect interactions of a different plausible future (i.e., scenario). Mr. Brown summarized the current work of the Subcommittee, noting that they first identified a focal issue or decision (i.e., question). The second step was to identify key factors influencing the success or failure in addressing an issue. Mr. Brown provided an example of using the simplified scenario planning process and noted that the Subcommittee will meet on September 30th to continue to work on the paper.

Biennial Storage Program Assessment

Mr. Brown provided an update on the paper that is scheduled for completion in 2016. He explained that the Subcommittee was formed in March 2008 in response to Title VI, Section 641(e)(5) of Energy Independence and Security Act of 2007 (EISA) that tasked the Subcommittee with assessing the performance of the Department's storage program every two years and developing a storage plan every five years. The 2016 Biennial Storage Program Review Report will focus on assessing the DOE storage program and providing Committee recommendations. The Subcommittee plans to begin the assessment by revisiting several sources that were suggested by DOE and span from 2012 through 2015. He noted that approval is slated for the October 2016 EAC meeting and welcomed EAC members to participate in the process.

Mr. Ball commented that the five-year plan will coincide with the two-year review. Mr. Brown confirmed that the reports will overlap. He requested additional assistance from EAC members to help complete both work products.

Ms. Tierney asked for additional information on the scenarios and Mr. Brown responded that the electric industry can use the scenarios to bring DOE's attention to future grid issues and to ask for assistance to address these issues.

EAC Power Delivery Subcommittee Activities and Plans

Mr. David Till, EAC Power Delivery Subcommittee Chair, provided an update on the Power

Delivery Subcommittee activities and plans.

Recommendations on Electric Grid Voltage Support

Mr. Till explained that the current draft of the paper will be distributed to the Subcommittee for review but noted that it is not yet complete. The Subcommittee will have one week to submit comments before the draft is circulated to the full EAC for review. Mr. Till stated that a webinar will be held to discuss final comments.

Reactive Power and Load Transient Behavior Issues

Mr. John Undrill, Arizona State University, provided an overview of reactive power and load transient behavior issues. Mr. Undrill began by presenting various graphs to demonstrate voltage dip and the various results of the synchronous generator and condenser over a specific timeframe.

Mr. Undrill commented on the inertia constant of industrial motors and presented several graphs to demonstrate this idea. He reviewed air conditioner motors and noted that delayed voltage recovery is recognized to be associated with behavior of residential air conditioners with direct-connected compressor motors.

Mr. Undrill explained the traditional sources of reactive power and noted that those sources will gradually be phased out. He cautioned that there needs to be a reasonable way to anticipate what is going to happen to the sources coming onto the system. Mr. Undrill summarized that the future of air conditioning load will evolve and penetrations of electronically coupled motors will increase rapidly across the full field of driven loads. Electronics in the past have been coordinated between the supplying sources and the electric grid.

Mr. Brown and Mr. Undrill discussed the ability to model behavior and loss of building inertia. Behavior can be modeled but technology is not ready for system integration. Moving a system to electric does result in loss of building inertia, which is not a problem on the system side but can pose a problem on the consumer side. Ms. Tierney asked which party is responsible for addressing this issue and Mr. Undrill explained that the electric utility is responsible for bringing these issues to the attention of the rest of the involved parties (including DOE). Mr. Gellings raised the concern that, because everything is controlled by electronic industries, digital loads are an issue. He noted the broader problem of engaging the involved parties in product development to address these issues.

Mr. Roberti asked if the problem would be solved if there were standards established by DOE for manufacturers but Mr. Undrill responded that this statement is stronger than he is comfortable endorsing. He noted that having standards too early in the regulatory process would cause issues with the technology evolution. The industry should be responsible for completing the research and bring results to the attention of the regulators.

EAC Smart Grid Subcommittee Activities and Plans

Status of Distributed Energy Storage Paper

Mr. Carlos Coe provided an update on the Distributed Energy Storage (DES) paper that was a joint effort with the Energy Storage Subcommittee. Mr. Coe explained that DES is energy storage that is located at or down stream of distribution substations, which includes behind the meter applications, thermal energy storage, and microgrids. The purpose and goal of the DES paper is to characterize DES status, identify gaps, and provide recommendations to DOE.

Mr. Coe presented the DES projects map and highlighted recent DES news. Oncor submitted a \$5 billion proposal to ERCOT for DES that addresses the majority of system contingencies with DES. He highlighted Tesla's DES product offering that includes a partnership with SolarCity and other major utilities. In addition to inclusion of DES news in the paper, expert interviews were also incorporated, but the topic of thermal storage was not discussed in the interviews.

Mr. Coe reviewed the seven draft recommendations of the DES white paper and presented the paper status and work plan. The draft white paper was completed in September 2015 and the final white paper is scheduled to be completed by March 2016. The Smart Grid Subcommittee will follow the same process as the Energy Storage Subcommittee and will hold a webinar before approving the white paper text.

Mr. Centolella suggested that the issue of using physical inertia as storage included in the appendix be made clear in the paper. Mr. Coe responded that the high penetration of storage paper will point out and include discussion on these areas.

Mr. Morris commented that the storage process is at a disadvantage because storage offers no addition to the system. Mr. Coe explained that the challenge is determining how to develop confidence that storage can replace generation assets. The answer is in the planning process and it might be 5-10 years before it becomes a true capacity option.

ARRA Accomplishments and Recommendations for Moving Forward

Ms. Reder provided a high level outline of the ARRA Accomplishments and the Recommendations for Moving Forward paper and reviewed each of the five chapters (i.e., background and purpose, power system transformation, current status of smart grid deployment and lessons from ARRA program, recommendations and future steps, and summary). Chapter 4, Recommendations and Future Steps, was the focus of the paper and included discussion on capability enhancement, technology performance improvements, further development of the business case and institutional support, and system integration. She noted that the EAC survey is included at the end of the paper and highlighted the newly added text to Section 3.2.2, Institutional Development. The newly added text explains the Grid Modernization Index report that was published by GridWise Alliance in July 2013, which included a ranking of states' grid modernization efforts in the United States.

Mr. Shelton asked if the paper reviewed the efficiency or governance of the ARRA programs (specifically on the demonstration projects) and Ms. Reder confirmed that the efficiency of the ARRA programs was included. The report indicated that some programs were more successful than others, but recognized the aggregate accomplishments of the grant activity. Ms. Wagner

suggested that DOE and regulators continue to build on Section 4.3: Further Development of the Business Case and Institutional Support.

Ms. Reder moved to approve the ARRA Accomplishments and Recommendations for Moving Forward paper. Mr. Roberti seconded the movement. The Grid Modernization: ARRA Accomplishments and Recommendations for Moving Forward paper was passed unanimously.

Ms. Reder provided an update on the future work products of the Subcommittee. She explained that the Subcommittee decided not to pursue the Reflections on EPA Clean Power Plan 111(d) and Microgrid work product papers. She noted two new suggested topics for the Subcommittee. The Internet of Things for Electric Grid paper would include a far ranging vision, possible applications, achieving “plug and play,” big data implications, and recommendations. The Development of Markets at the Distribution Level paper would include models, control and dispatch of distributed resources, architecture needs, and recommended actions.

Mr. Shelton supported both paper topics and suggested combining them into one paper. Mr. Gellings opposed the idea and explained that virtually all devices will be able to integrate with the grid so DOE should focus on what can be done now to prepare for the revolution in electricity.

Mr. Bose cautioned against using the term “big data.” Ms. Marilyn Brown noted that the issues of security and intellectual property should be included in the data discussion. Mr. Centolella suggested limiting the scope of the topic to include only relevant areas.

Wrap-up and Adjourn Day One of the September 2015 Meeting of the EAC

Mr. Cowart, EAC Chair, thanked everyone for their comments and adjourned the first day of the meeting.

Respectfully Submitted and Certified as Accurate,



Richard Cowart
Regulatory Assistance Project
Chair
DOE Electricity Advisory Committee

11/18/2015

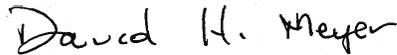
Date



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Date



David Meyer
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